

Portland East Quadrangle, Maine

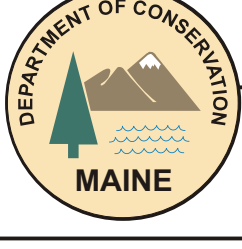
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by a 12 p. report.

On the geologic map, different bedrock units are indicated by colors and identified by letter symbols that represent their assigned age and unit name. The Flying Point and Johns Point faults divide the map into three parts, each having a different set of rock units. The following description summarizes the major rock types of each unit, and gives a simplified geologic history by which they formed.

MAJOR ROCK TYPES

The stratified, or layered, rocks of the Portland East quadrangle are all metamorphic rocks, including schist, phyllite, gneiss, granofels, and amphibolite. Schist consists mostly of thin, flat flakes of mica which are arranged parallel to each other such that the rock splits into sheets. Phyllite has a similar mineral texture except the individual grains are very small and not readily seen without a microscope. Gneiss is a type of layered rock in which the different minerals are concentrated in separate, irregular streaks or layers. Granofels, made up primarily of the minerals quartz and feldspar, has a grainy texture somewhat like sugar. In contrast with schist and phyllite, gneiss and granofels tend to break into angular blocks or chunks. Amphibolite is a rock named for dark grains of the mineral amphibole, the principal constituent of the rock. Varieties of gneiss, schist, and granofels may be further distinguished by their particular mineral content, grain size, color, or other characteristics.

ORIGIN OF THE STRATIFIED ROCKS

The oldest rocks of the Portland East quadrangle, southeast of the Johns Point fault, belong to the Casco Bay Group, a diverse assortment of metamorphosed volcanic rocks, shales, and limestone, deposited during Ordovician time (see Geologic Time Scale, below). The oldest unit of the Casco Bay Group is the Cushing Formation, a thick pile of light gray volcanic material (Photo 1), composed of coarse angular blocks of volcanic breccia and fine volcanic ash with crystals of quartz and feldspar (Photo 2). These rocks formed as hot lava erupted on an ancient ocean floor and became fragmented on contact with the cold ocean water. As volcanic activity ended, shale and siltstone of the Cape Elizabeth Formation accumulated conformably on top of the volcanic pile. Near the base of the Cape Elizabeth Formation, beds of volcanic ash, similar in composition to the Cushing volcanic rocks, were deposited intermittently (Photo 3) when slopes of the volcanic pile slumped and were transported by currents to where the Cape Elizabeth shale and siltstone were being deposited. A period of renewed volcanism ensued, depositing basaltic ash and breccia of the Spring Point Formation (Photos 4 and 5). In places, dark shale of the Diamond Island Formation (Photo 6), rich in organic matter and iron sulfide, accumulated after cessation of the basaltic volcanism. This was followed by accumulation of more shale and siltstone, of the Scarboro and Jewell Formations, and shaly limestone of the Spurwink Metalimestone (Figure 7).

Rocks of the Falmouth-Brunswick sequence, along the Falmouth shore, are represented by the Nehumkeag Pond Formation which consists of a thick, heterogeneous pile of metamorphosed feldspar-rich sandstone, iron sulfide-rich shale, and sporadically-interbedded volcanic ash of basaltic composition. The age of these rocks is poorly constrained but is thought to be Ordovician. Their original relationship to the Casco Bay Group is uncertain because the two sequences are now separated by faults, and have distinctively different grades of metamorphism.

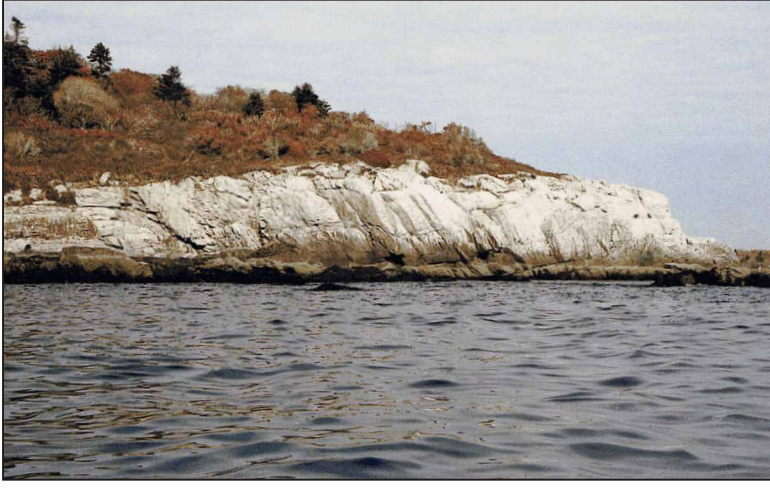


Photo 1. Cushing Formation. Light gray metamorphosed volcanic rocks. (Cushing Island near Whitehead)



Photo 3. Cape Elizabeth Formation. Metamorphosed sedimentary beds in the lower part of the formation. The light gray beds of volcanic ash, similar to those in the Cushing Formation, were redeposited when slopes of the unconsolidated tuff failed repeatedly, producing bottom-hugging currents of turbid water. As the currents slowed, coarser grains of the ash settled first, followed by gradually finer-grained, dark-colored mud. (Long Cove, Long Island)



Photo 5. Spring Point Formation. Coarse volcanic breccia. White chunks are rock fragments blown from a volcanic vent. (Little Diamond Island)



Photo 7. Spurwink Metalimestone. Thinly layered, buff-weathering metamorphosed muddy limestone. The steep inclination of the layering, a common feature of this map area, indicates the rocks have been deformed from their original flat-lying orientation. (Cow Island)



Photo 9. Hutchins Corner Formation. Gray gneiss of the Hutchins Corner Formation here has been extensively injected by parallel layers and lenses of light-gray pegmatite. Thin beds of greenish gray gneiss, which were originally limy and muddy sandstone, are interbedded with the gray gneiss. (Falmouth Connector between I-295 and the Maine Turnpike, Falmouth)



Photo 11. Cape Elizabeth Formation. Thinly bedded, metamorphosed feldspar-rich siltstone (lighter bands) and shale, 5 meters west of the contact with the Cushing Formation. The thin layers are folded very tightly, while the stout white quartz vein to the left has more open fold shapes. (Long Cove, Long Island)

The Merrimack Group, much more extensive in the southwestern part of Maine, is represented in the Portland East quadrangle by a thin strip of Eliot Formation, between the Johns Point and Flying Point faults. Here it consists of slightly metamorphosed calcareous siltstone and shale with interbedded layers of very rusty weathering shale (Photo 8). These rocks are interpreted to be deep ocean sediments deposited during Late Ordovician to Early Silurian time.

The Central Maine sequence, in the northwest corner of the map, was deposited during Late Ordovician to Early Silurian time. It consists of highly metamorphosed calcareous and non-calcareous sandstone and siltstone (Hutchins Corner Formation) and slightly muddy sandstone and siltstone (Richmond Corner Formation), also deposited in a marine environment. These rocks were extensively injected by magma, now preserved as conformable layers of light-colored granitic pegmatite (Photo 9).

DEFORMATION, METAMORPHISM, FAULTING, AND IGNEOUS INTRUSION

Rocks of all the stratified sequences were complexly folded during a period of major regional deformation and mountain-building known as the Acadian orogeny, in Early to Middle Devonian time. Large-scale deformation of the Earth's crust is indicated by large folds in the map pattern and cross-sections; minor folds and other internal structural complexities can be seen in outcrop at many localities (Photos 10 and 11). During late stages of this active deformation period, the rocks were forced to deep levels in the Earth's crust where heat and pressure gradually transformed the sedimentary rocks into the metamorphic rocks that we see now. Shale was transformed into phyllite and schist; sandstones became granofels and gneiss; volcanic ash and breccia of basaltic composition became amphibolite. The intensity of metamorphism was not everywhere the same. Some rocks became hot enough to melt, yielding granitic magma that was injected as stringers into the metamorphic rocks to produce strikingly banded rocks (Photo 9). Some of the magma was injected into cross-cutting cracks and cooled to form dikes of a very coarse-grained granite known as pegmatite.

After the Acadian orogeny the rocks of the quadrangle were subjected to major faulting and shearing while still deep in the Earth's crust, forming part of the Norumbega fault zone. Shear bands, disrupted white quartz veins, and many similar small structures that formed during this event attest to the fact that rocks sheared past each other in a right-lateral sense; i.e., rocks on the east moved south and rocks on the west moved north. This ancient fault zone in some ways resembles the present-day San Andreas fault in California. Later faulting, with vertical rather than sideways motion, formed the major normal faults of the quadrangle, the Flying Point, Fore River, and South Portland faults.

The youngest rocks in the area are the numerous dark-colored basalt and diabase dikes. They formed when basaltic magma was injected into extensional fractures produced during continental rifting of the incipient Atlantic Ocean in Mesozoic time. These widely scattered dikes are typically a few inches to a few feet thick (Photo 12), but one, the Christmas Cove dike, is nearly 100 feet wide and has been traced 75 miles east-northeast to the Port Clyde area. The present landscape and ocean bathymetry are fundamentally controlled by uneven erosion of the complex underlying bedrock geology over great spans of time, modified by recent and ongoing surface processes.

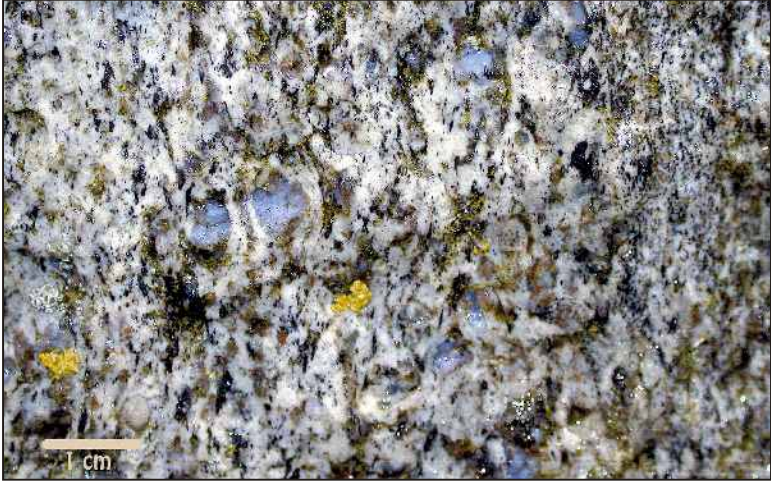


Photo 2. Cushing Formation. Gneiss derived from volcanic ash with conspicuous crystals of blue quartz. (Danford Cove, South Portland)



Photo 4. Spring Point Formation. Massive deposit of fine-grained, metamorphosed volcanic ash. (Fish Point, Portland, beneath Fort Allen Park, next to narrow gauge railroad)



Photo 6. Diamond Island Formation. Rusty-weathering black phyllite (foreground) rests against greenish volcanic ash of the Spring Point Formation (background). Fort Prebble at far right. (Southern Maine Technical College, South Portland)



Photo 8. Eliot Formation. Gray calcareous metamorphosed siltstone, with very rusty-weathering, dark gray contorted phyllite in foreground. (Southeastern side of Mackworth Island)

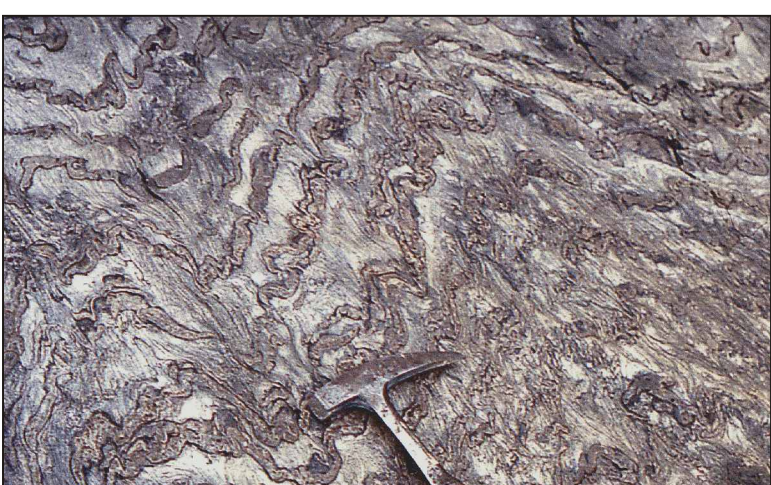


Photo 10. Cushing Formation, coticle member. Beautifully folded layers of garnet-rich granofels. These folds formed as a result of compression of the Earth's crust during the Acadian orogeny. (House Island)

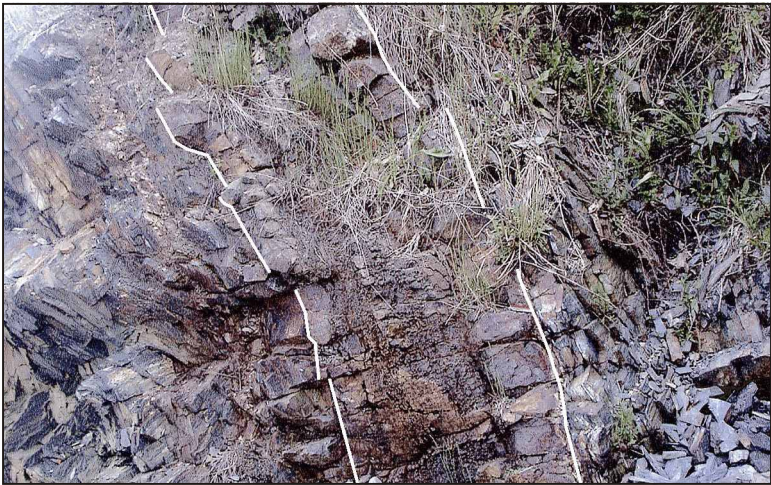


Photo 12. Three-foot thick diabase dike cutting the Diamond Island Formation. Edges of the dike are highlighted by the lines. Magma of the dike is more blocky than its interior. (Southern Maine Technical College, South Portland)